



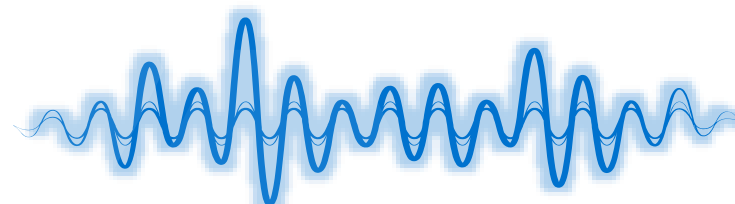
AAC TECHNOLOGIES

Design of an Integrated mmWave Phase Array Antenna Structure with RF-Front End for 5G 用于5G的带射频前端的集成毫米波相控阵天线结构的设计

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AAC Singapore Wireless Technology Centre





AAC TECHNOLOGIES

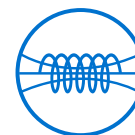
**6
Product
Lines**



Acoustics



Optics



EM Drives



**Precision
Processing**



**RF &
Antennas**



MEMS

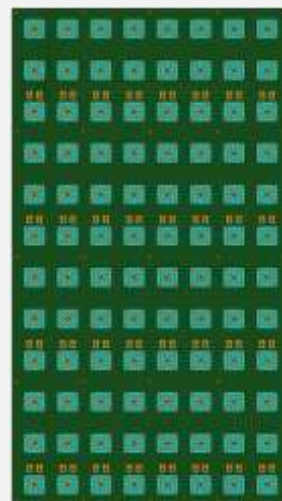
**21.1B RMB
(~3.3B USD)
Revenue in 2017**

**15
Global
R&D Sites**

**7
Manufacturing
Sites**



**Massive MIMO
antenna**



LDS



Frame + LDS
antenna



Box LDS



SPK BOX LDS
antenna



LCP&MPI*



LCP/MPI antenna
+ RF connector



Metal cover



Metal cover
antenna



Metal Frame



Metal frame
antenna



**MEMS
TUNER**

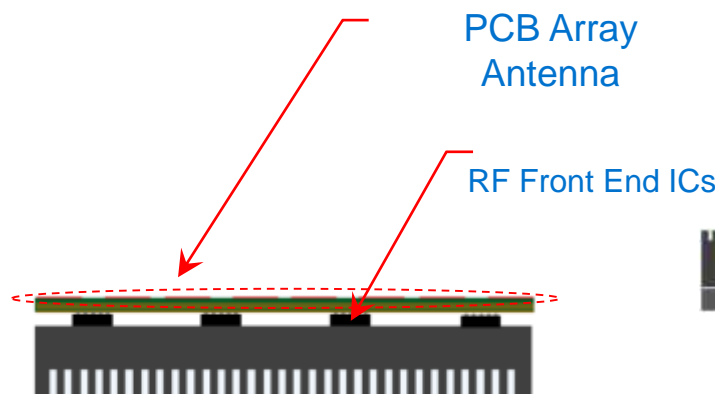


MEMS TUNER

CONTENT

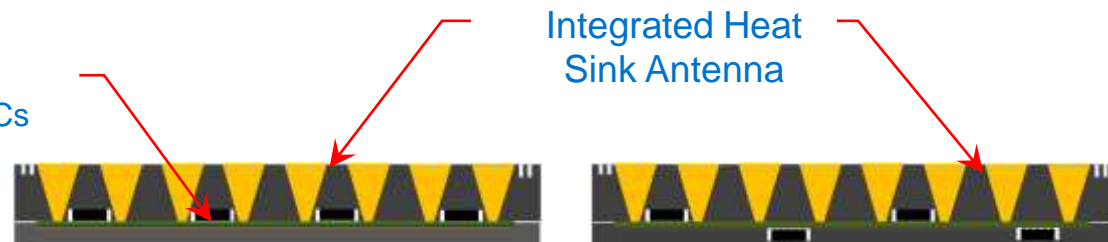
- ◆ Concept
- ◆ Proof of Concept Simulation/Measurement
- ◆ 2x2 Element Phase Array
- ◆ M x M Phase Array
- ◆ Prototype of 64-Elements Array
- ◆ Acknowledgement
- ◆ Question and Answer

Concept



Planar Phase Array Antenna with Heat Sink

Phase Array Antenna is design using the PCB layer stack up



Planar Phase Array Antenna Integrated with Heat Sink

Phase Array Antenna Element are design into the heat sink in 3D form. mmWave RF front End ICs are mounted in the heat sink cavity at the same time function as a RF shield

Concept

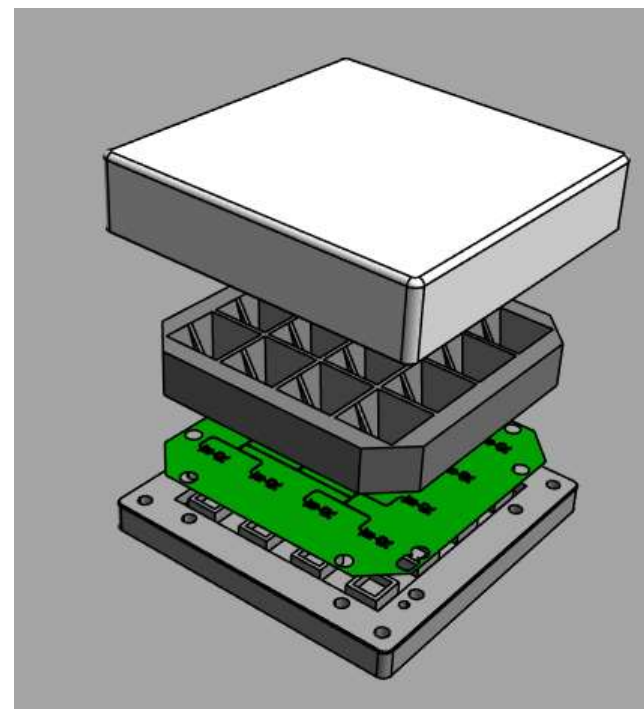
Planar Phase Array Antenna Integrated with Heat Sink

- Simplified PCB structure for Integrated Antenna and RF-Front End
- 3D structure can be design to function as an shield and heatsink
- Antenna and RF-Front End can be decoupled to enable testing or calibration can be conducted before assembly

Integrated Heat Sink Antenna



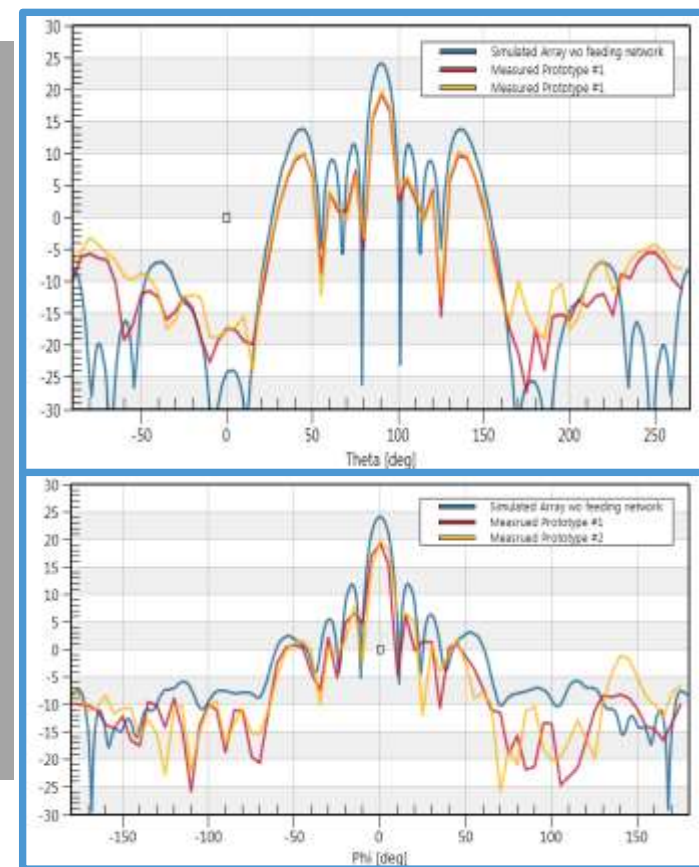
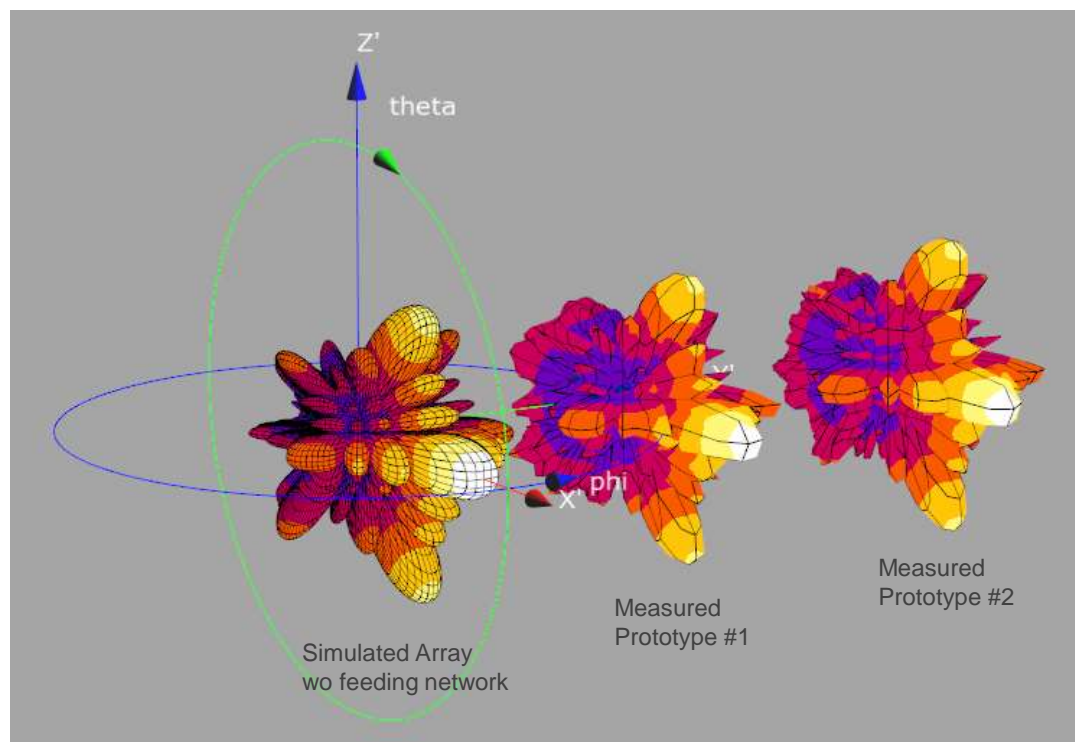
Proof of Concept Simulation/Measurement



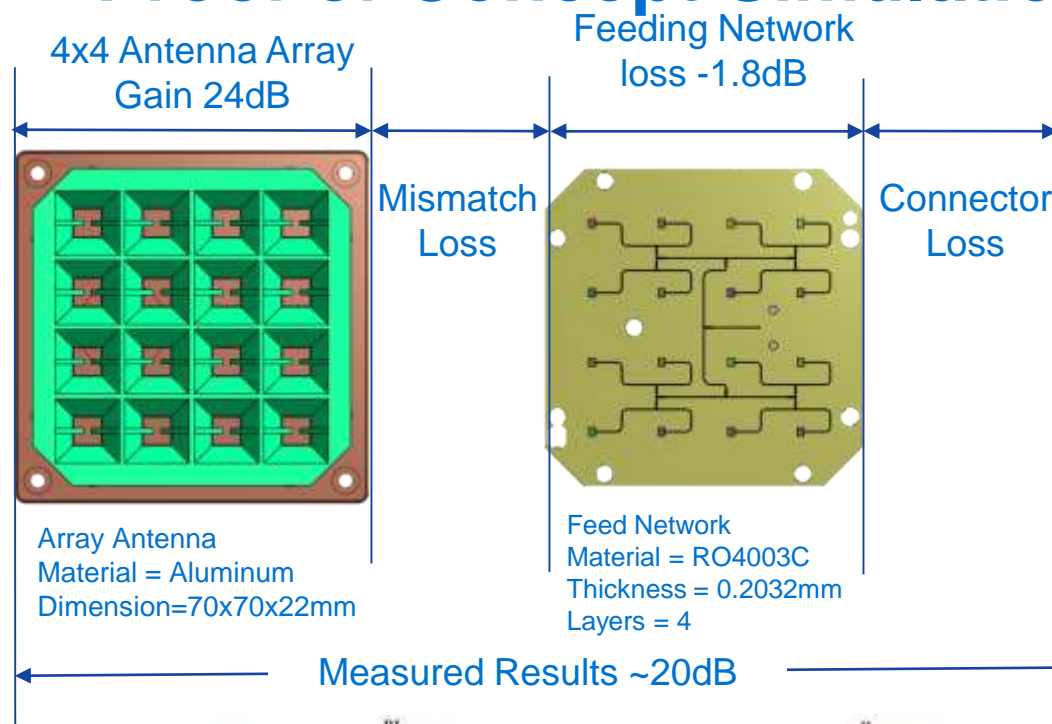
Proof of Concept Simulation/Measurement

Simulation are conducted using SEMCAD-X and radiated measurement performed in Anechoic Chamber are results imported into SEMCAD-X for comparison.

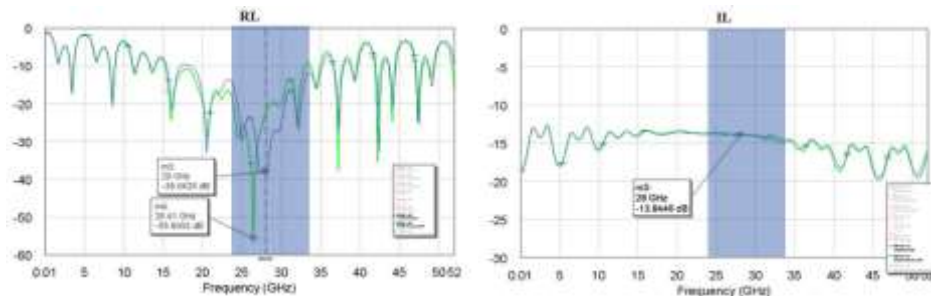
Simulation, Field Measurement and Chamber Measurement are fully portable in to common tools, SEMCAD-X, for validation.



Proof of Concept Simulation/Measurement

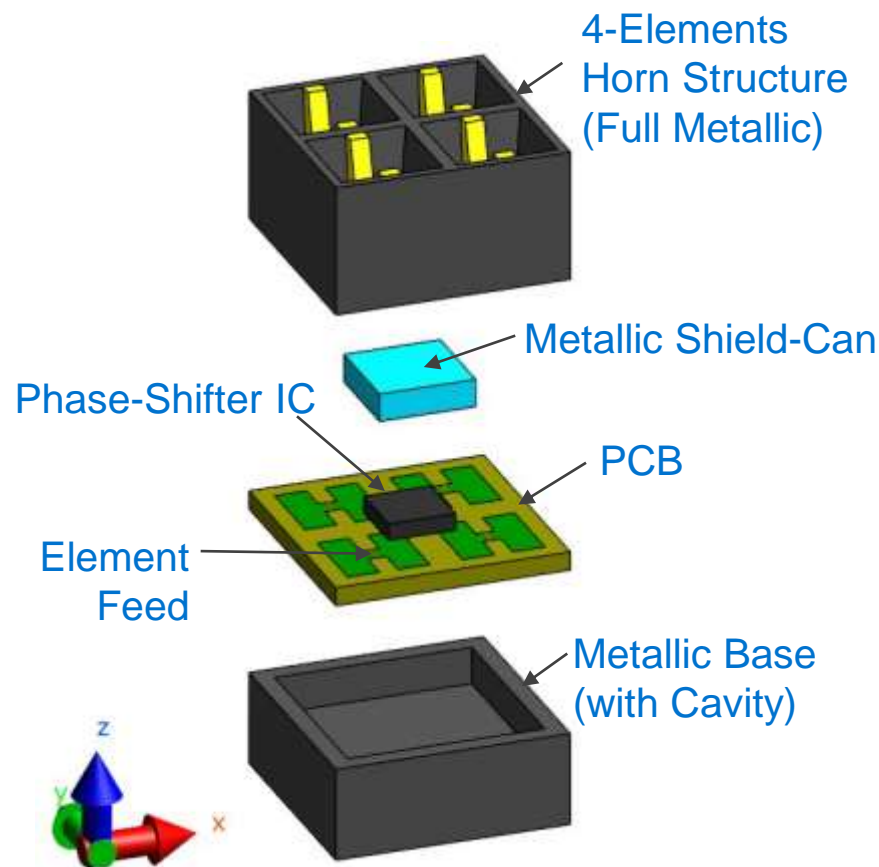


- Array Antenna is simulated Gain = 24dB
- The Power divider network loss is ~1.8dB.
- Overall simulation is about 2dB lower (not taking account of the feed mechanism and transitions losses.)

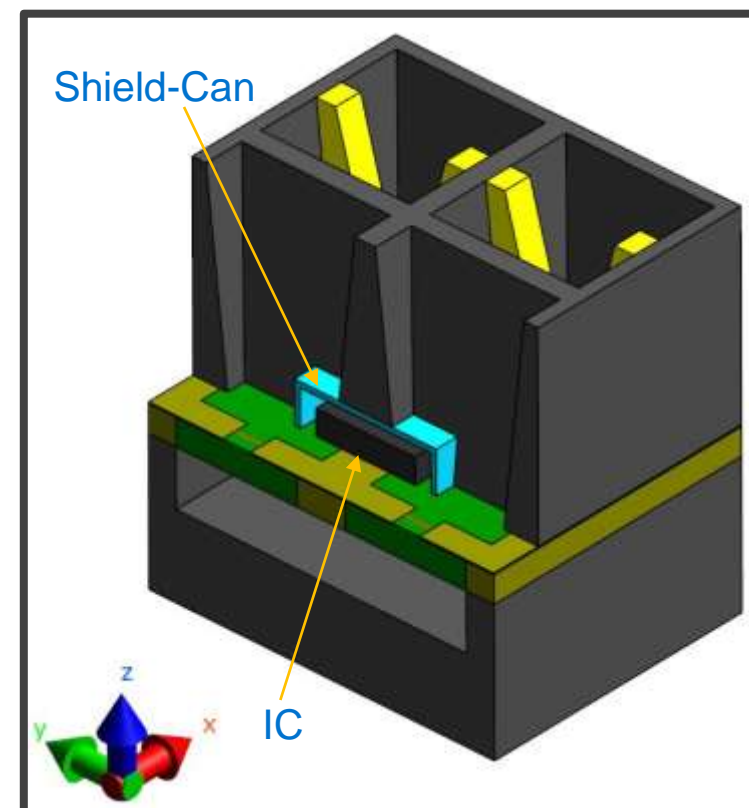


S-Parameter of Simulated Power Divider Network

2-By-2 Sub-Array Horn Antenna [28GHz]



3D Stack-up

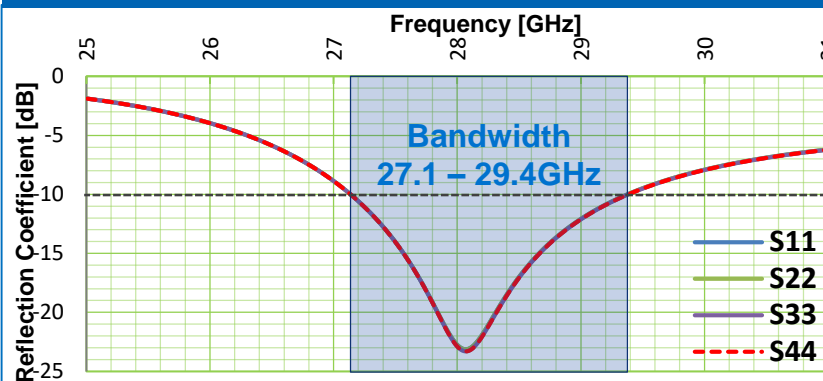


Cross-sectional view of Sub-Array

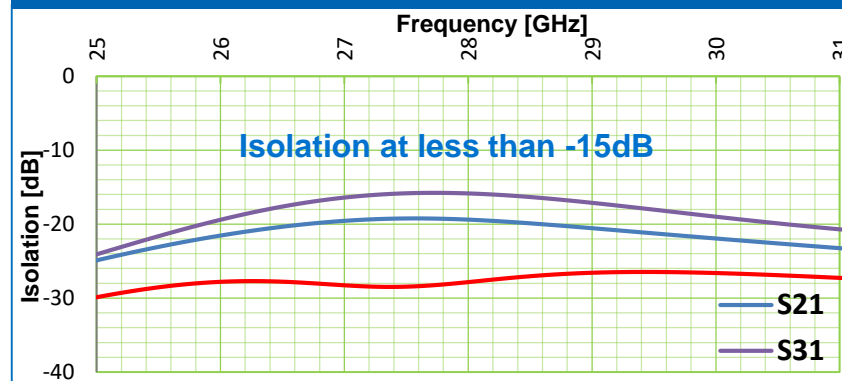
- Overall dimension: 12.55mm by 12.55mm by 13mm

Performance of 2-By-2 Sub-Array Horn Antenna

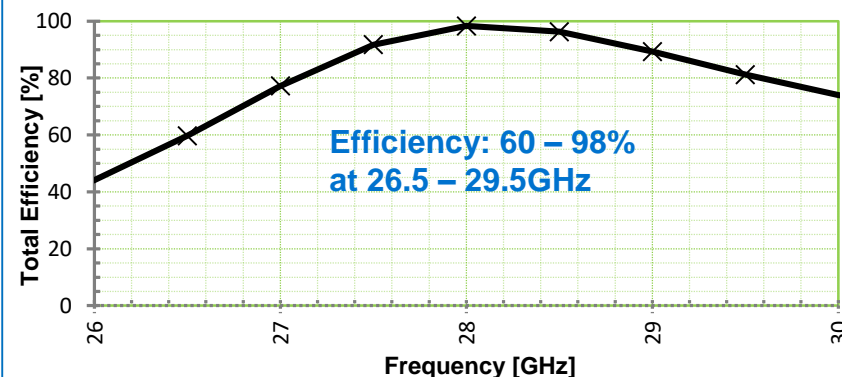
Reflection Coefficient



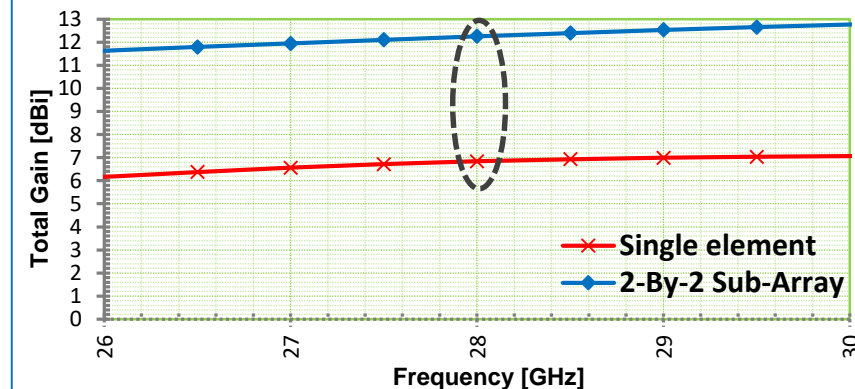
Isolation



Total Efficiency

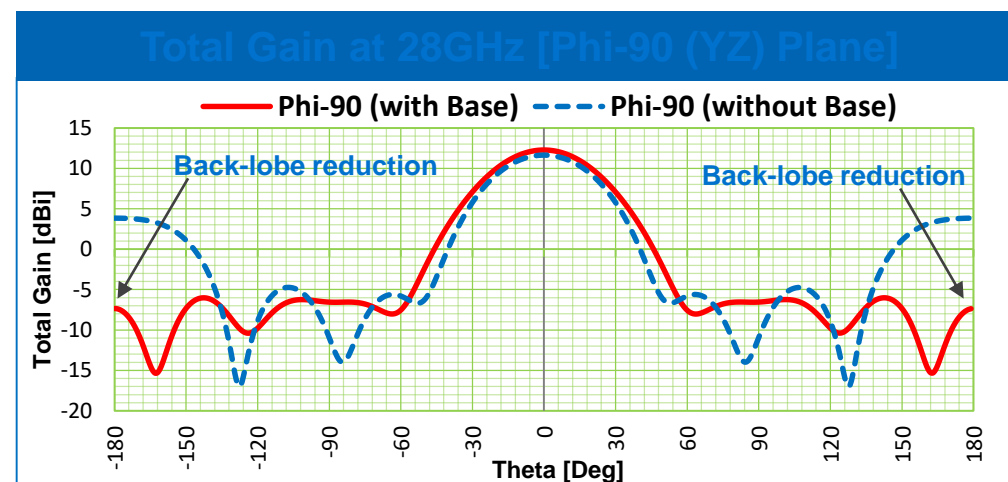
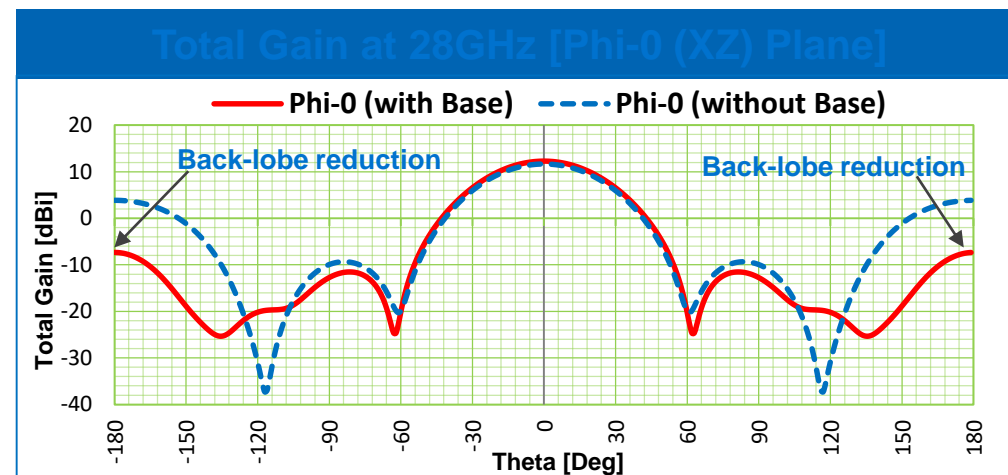
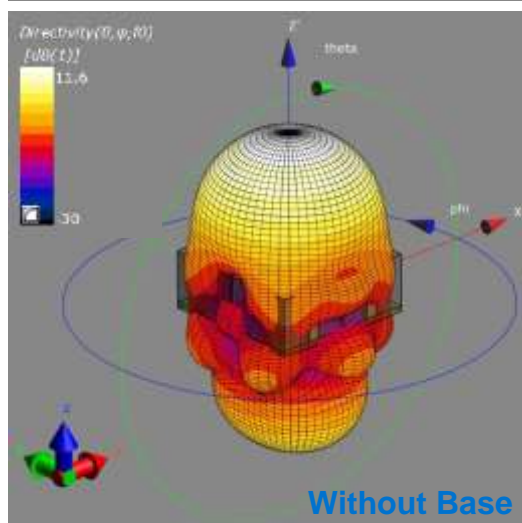
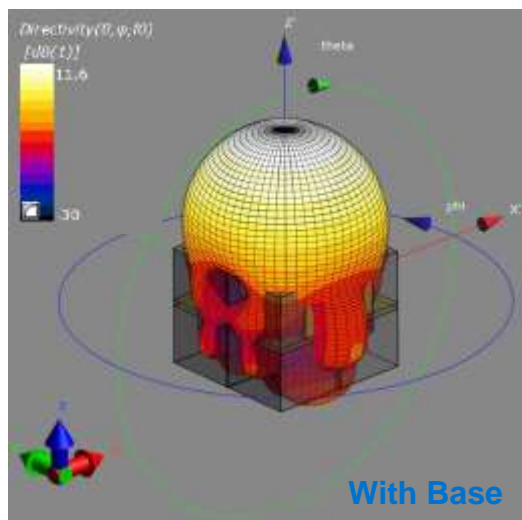


Antenna Total Gain



Total Gain at 28GHz: 6.84dBi (Single);
12.25dBi (2-By-2 Sub-Array)

2-By-2 Sub-Array: Radiation Pattern [at 28GHz]



28GHz Scalable Phased Array Horn Antenna

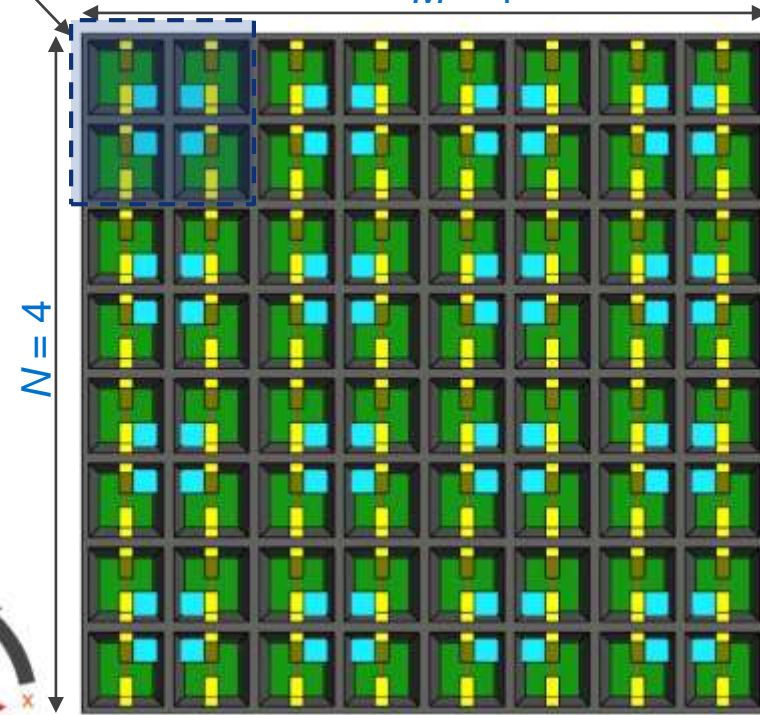
Phased Array Horn Antenna utilizes multiple numbers of the 2-By-2 Sub-Array Horn Antenna to form an $M \times N$ rectangular array, where

- M is the number of columns of Sub-Array Horn Antenna in Phased Array Horn Antenna;
- N is the number of rows of Sub-Array Horn Antenna in Phased Array Horn Antenna;

Configuration	Column, M	Row, N	Antenna Element (Matrix)
Array_4	2	2	16 (4 x 4)
Array_16	4	4	64 (8 x 8)
Array_32	8	4	128 (16 x 8)
Array_64	8	8	256 (16 x 16)

2-By-2 Sub-Array

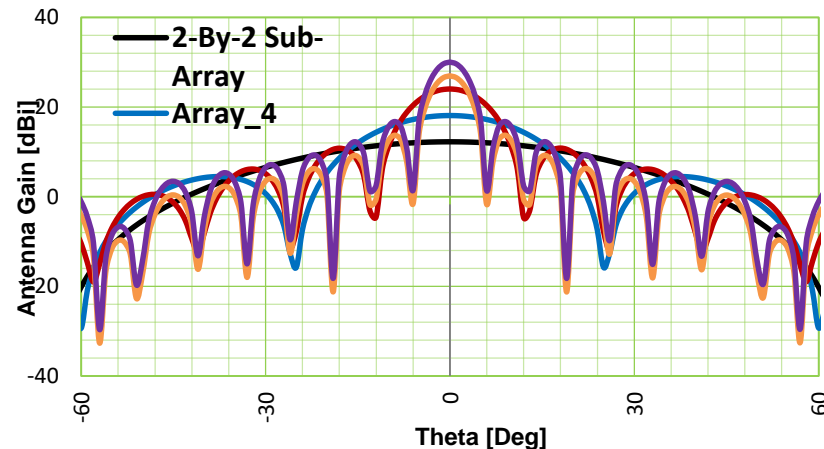
$M = 4$



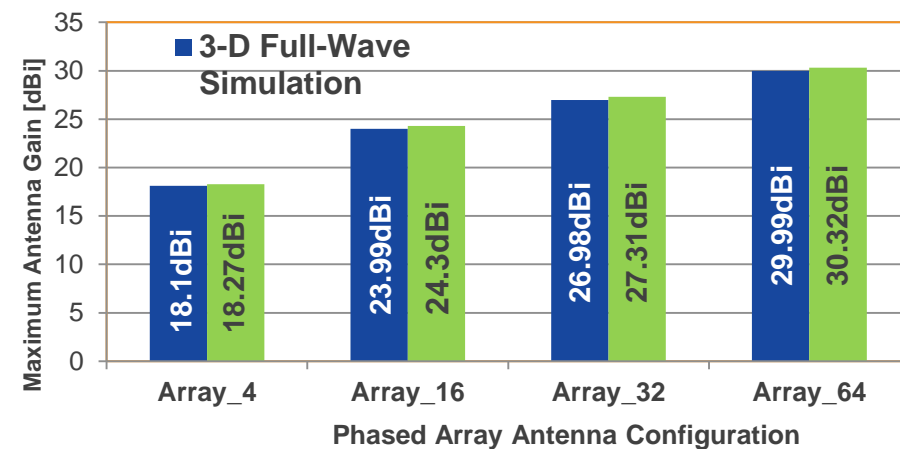
Example of Array_16 (8 x 8) Layout

Phased Array Antenna Beam Profile at Scan-0

Total Gain at 28GHz [Phi-0 (XZ) Plane]

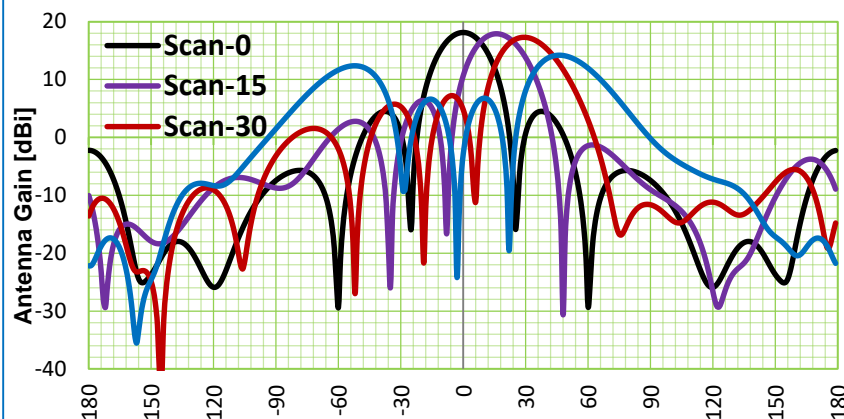


Comparison with Theoretical Calculation

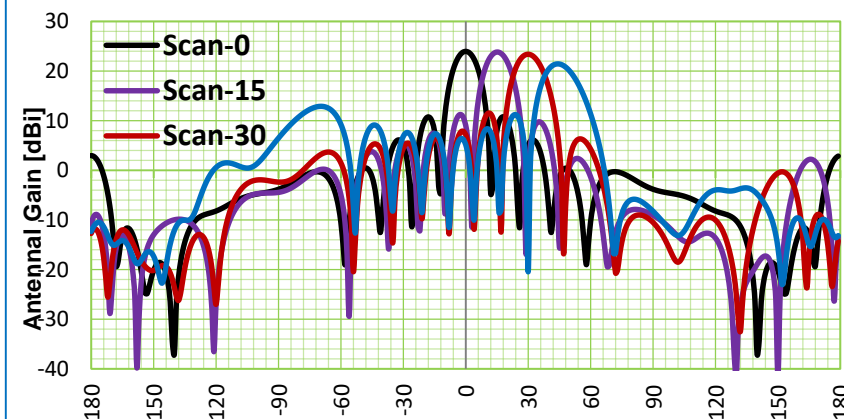


Beam-Steering Profile on Phi-0 Plane [28GHz]

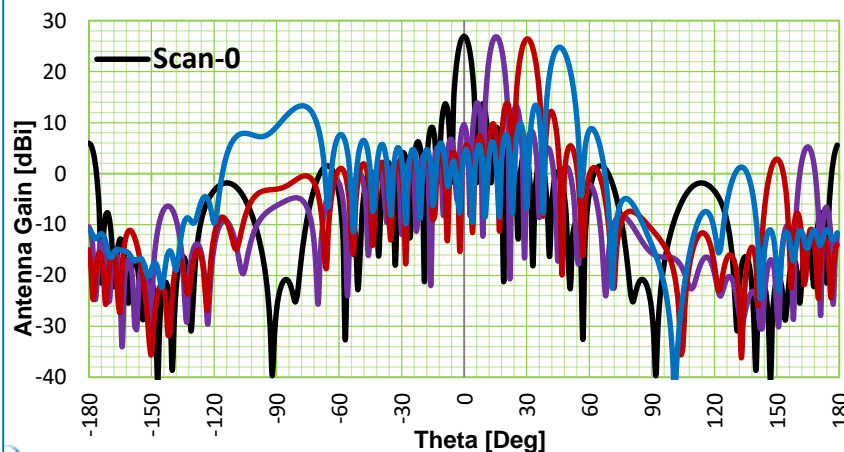
Array_4 (16-Elements)



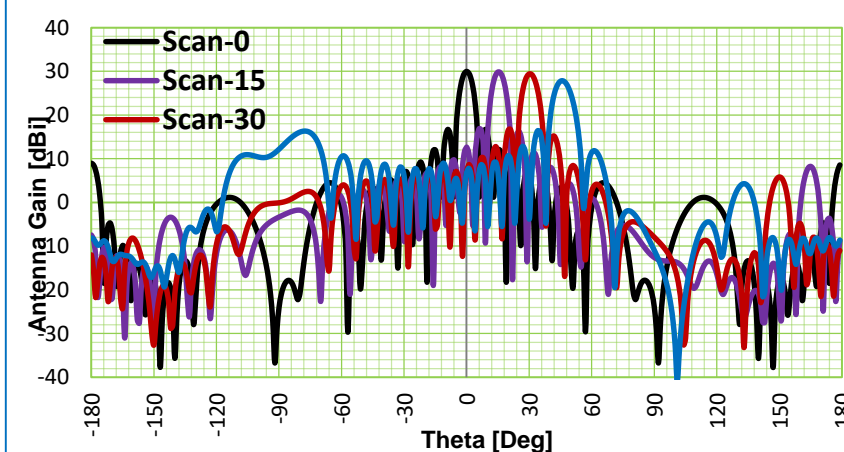
Array_16 (64-Elements)



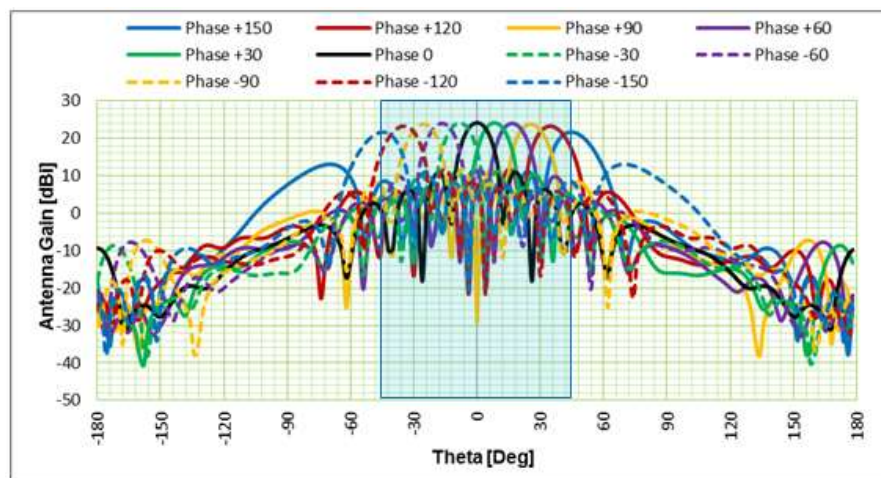
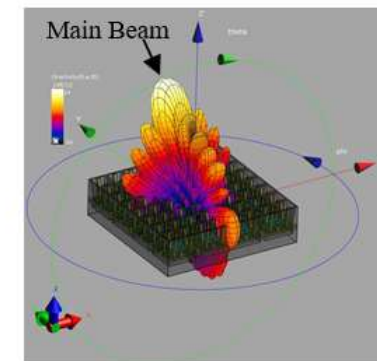
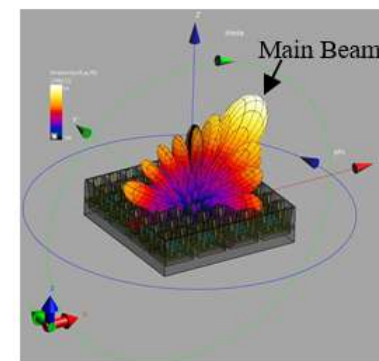
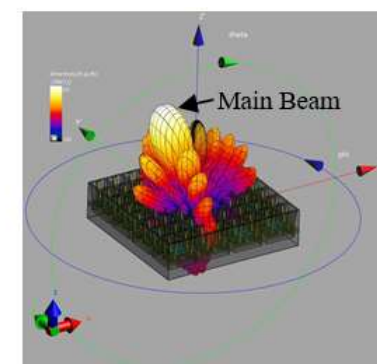
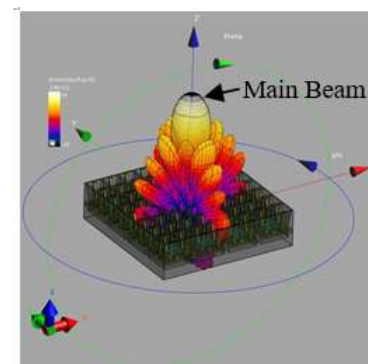
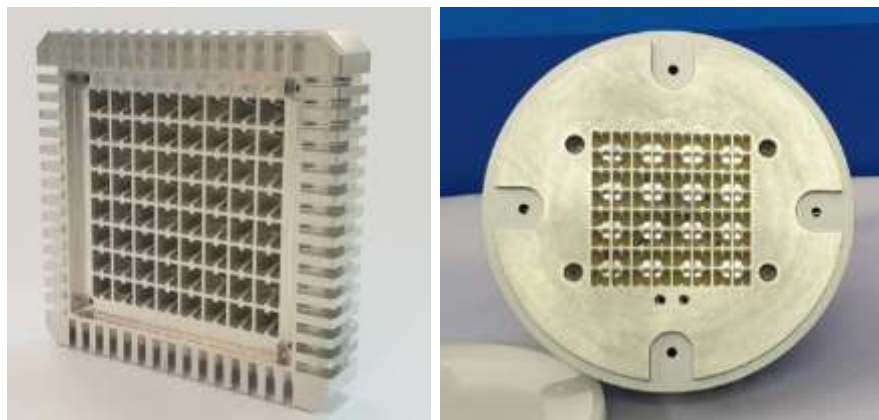
Array_32 (128-Elements)



Array_16 (256-Elements)



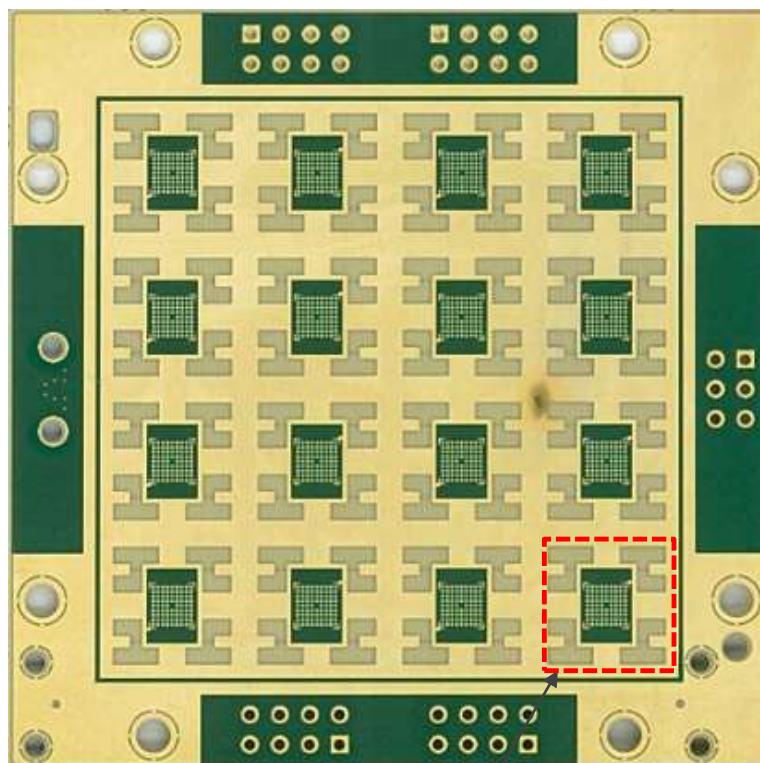
Prototype of 64-Elements Array



(a) Horizontal scanning on Phi-0° plane

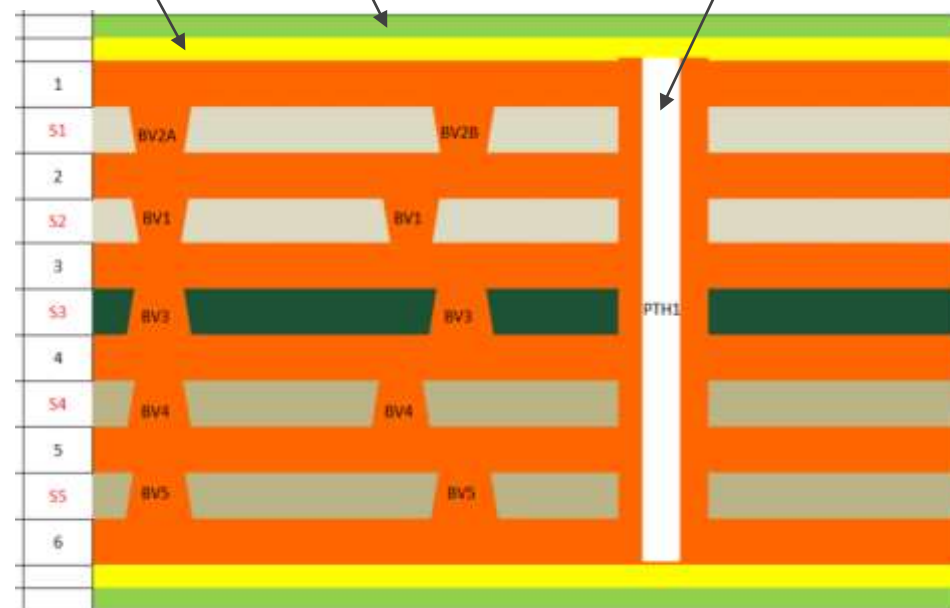
Prototype of 64-Elements Array

PCB for Prototype



For one 2-By-2 Sub-Array

Surface Finishing Solder Mask Through-Hole Via



Stack-up of PCB

- Even stack-up of 6 layers
- Total thickness 0.638mm
- Megtron (Dielectric Constant: 3.13)

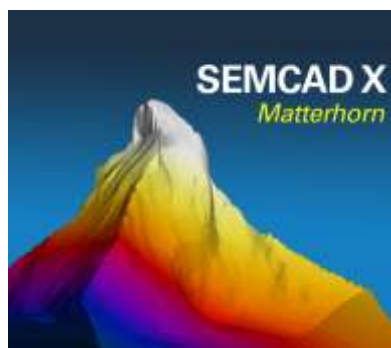
Further Reference

13th European Conference on Antennas Propagation (EuCAP2019)

A 2-By-2 Sub-Array for Scalable 28GHz mmWave Phased Array Horn Antenna in 5G Network

Mark TAN Y. C., NG Guan Hong, Roger TAY Y. S.

Acknowledgement





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Questions?

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THANK YOU

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